CE 203 : FLUID MECHANICS

LECTURE 1

06 - JAN - 2016

INTRODUCTION

On the first day of this lecture series, may I welcome you all.

→ This course is on Fluid mechanics.

→ As an engineering student, you have been dealing with the term mechanics from your first year curriculum itself.

→ You have studied classical mechanics, engineering mechanics, etc. in your first year curriculum.

→ There you know that there are two portions in mechanics

* Statics
* Dynamics

→ Subsequently you studied Solid Mechanics.

There you might have seen about

* Force
* Conservation of mass, linear momentum, angular momentum, etc
* Deformation, Stress, etc.

Without going in to contents in solid mechanics, now we will discuss about fluid mechanics.

Q: What is fluid ?

An object occupying ~~spa~~ volume in space that does ~~not~~ have its independent ~~shape~~. It cannot resist shear.

* Fluid mechanics
  → Study of fluid [→ In Motion (Fluid Dynamics)
                    → In Rest (Fluid Statics)

(Referred from FM White's "Fluid Mechanics" - 7th Edition)

→ You know fluids consist of [→ Gases
                               → Liquids

→ Fluid Mechanics is applied in :
  * Water, oil, gas, etc. pipe flows
  * Irrigation canals
  * Fans, turbines
  * Pumps
  * Engines
  * Filters, aeroplanes, ships, rivers, etc.

→ From your mechanics background, you are aware of well set of conservation principles and laws.

→ All those laws are very much applicable in fluid mechanics study as well.

→ However, it should also be noted that mere theory may not solve concerns on fluid and its flow.

* We need to develop workable theory that can be substantiated or maybe even developed based on experimental observations.
That is theory and experiments should go hand in hand.

Q: Have you ever thought of why you need to study fluid mechanics? What is the history of fluid mechanics?

Ans * As described in previous page, fluid mechanics is applied in wide fields

* As a Civil Engineer, when you graduate from this institute, you may be entering into various jobs or academics, etc.

* In some of the jobs, you may be required to design
  - ↳ say canals for irrigation, navigation, etc.
  - ↳ space craft shape
  - ↳ dams for multi-purpose objectives
  - ↳ measure the quantity and quality of water available on earth
    - ↳ surface water
    - ↳ ground water
  - ↳ Maybe if you diversify, you may have to design suitable blood pressure related equipments
  - ↳ And Design water supply network
  - ↳ Design oil fields, oil wells, etc.

There are many and to decide all here is impossible. However, you can browse through internet and try to collect enough information where FM is applied.

* In all the above cases, your knowledge on fluid mechanics is very much essential. That's why you need to study fluid mechanics.

History

* Use of water or its flowing properties for benefits has been witnessed from ancient times itself.
* It is reported that ancient Indus Valley Civilisation had water drainage networks.
* Roman empires used to transmit water through aqueducts.
* Fluid mechanics principles are very much seen in ancient weapons like
  - → arrows
  - → bows
  - → spears
  - → boomerangs, etc.

* Archimedes (285 - 212 BC) had formulated the laws of buoyancy (a very good case of fluid mechanics application) (Refered from FM White)
* From Christ period to Renaissance
  - → Improvement in flow systems
  - → Canals, ships, etc witnessed

* Leonardo Da Vinci (1452 - 1519) put forward the concept of conservation of mass in one dimensional steady flow. (Refered from FM White)

★ Issac Newton (1642 - 1727) was the first scientist to postulate laws on momentum.
→ He also introduced concept on viscosity.

★ In eighteenth century many scientists improved the knowledge in fluid mechanics
(e.g. Bernoulli, Euler, Lagrange, Laplace, etc.)

★ Some of the scientists in those period observed that their experimental observations were different from the earlier prescribed theoretical knowledge.
→ Scientists like Chezy, Manning, Weber, Hagen, Poiseuille, Darcy, etc produced data on various flows. They devised experimental relations between parameters without involving rigorous fundamental physics.

★ Subsequently the experimental and theoretical scientists began to unify in nineteenth century
→ Concepts on modeling
→ Dimensional analysis, etc. developed.
Scientists like Reynolds, Navier, Stokes, etc. were prominent

→ Also scientists like Prandtl, von Karman, etc. proposed theories on Boundary-layer flows.

→ The 20th century saw further rise in fluid mechanics concepts and applications.

Concepts on computational fluid mechanics and CFD were developed.

CFD is now widely used in

- → Aerospace engineering,
- → Hydraulic
- → Chemical reactors
- → Blood flow, etc.

→ You can apply fluid mechanics, anywhere you touch on earth → oceans, rivers, land, etc.

The Syllabus

In this course, we will go through

- ★ Fluid properties
- ★ Pressure measurement
- ★ Hydrostatic forces on plane and curved surfaces
- ★ Buoyancy and equilibrium
- ★ Stability and Metacentric height

* Types of flow
* Continuity, energy, linear momentum, angular momentum equations and conservations
* Navier-Stoke equations
* Flow through pipes
* Hagen-Poiseuille equation
* Turbulence
* Boundary-layer concept
* Dimensional analysis etc.

⇒ Our Text Book for the course is:

1) FRANK M. WHITE (2009) "Fluid Mechanics", ~~The~~ 7th Edn". The McGraw Hill Company.

2) FRANK M. WHITE (2008). "Fluid Mechanics, 6th Edition". Tata McGraw Hill

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In Our course, the students will be evaluated through

i) Assignments + Tutorials
ii) Short Quizzes
iii) Mid Semester Exam →
iv) End Semester Exam. → 35